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RESEARCH ARTICLE

LEADING COLLABORATION IN ONLINE COMMUNITIES[1]

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Despite the growing importance of online communities in creating knowledge and facilitating collaboration, there has been limited research examining the role of leaders in such settings. In this paper, we propose a framework that integrates behavioral and structural approaches to explore the antecedents of leadership in online communities focused on knowledge work. Specifically, we propose that sociability and knowledge contribution behaviors as well as structural social capital lead to being identified as a leader by members of the online community. We test this framework using social network, survey, and message-level content analysis data collected from three different online communities focused on technical topics. The results from our zero inflated negative binomial models, with 6,709 messages from 976 individuals, provide strong support for the framework that is developed in this study. Our study contributes to both theory and practice by identifying the behavioral and structural antecedents of leadership in online communities.

Keywords: Online leadership, leader behaviors, online communities, structural social capital, knowledge collaboration, network analysis

Introduction

In recent years, we have seen widespread use of new communication technologies that enable collections of individuals with common interests to congregate virtually and pursue shared interests, despite being separated by time and space (Preece 2000; Sproull and Arriaga 2007). Consequently, communication technologies ranging from blogs and wikis to listservs and newsgroups have emerged as spaces for social interactions. Some researchers have suggested that these "online communities" represent new forms of organizing (Fulk and DeSanctis 1995; Zammuto et al. 2007). Not only are online communities social interaction spaces, but they also have a wide-ranging impact on product development and knowledge creation (Holmstrom and Henfridsson 2006; Majchrzak, Wagner, and Yates 2013; Yoo et al. 2010). Arguably, much of the recent research in online communities is motivated by an interest in knowledge collaboration (Faraj et al. 2011).

However, knowledge collaboration in online communities poses several challenges for researchers. While there are

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many examples of successful large-scale collaborative plishments online (e.g., Kraut and Resnick 2012), our understanding of their structure and organization is limited (Kudaravalli and Faraj 2008). Researchers have noted that such collaborations tend to be loosely coordinated, self-organizing, and voluntary (Moon and Sproull 2002), as well as characterized by flattened hierarchies and the lack of formal structures (Dahlander and O'Mahony 2011). The associated weakening of traditional forms of control has led some observers to label them "leaderless organizations" (Brafman and Beckstrom 2006), while others have suggested that online communities are characterized by fluidity and temporary "roles in the moment," resulting in leadership that is fleeting at best (Faraj et al. 2011). This raises the question: How is knowledge collaboration sustained in the absence of formal leaders, hierarchy, and control mechanisms used in traditional organizations? On the other hand, anecdotal evidence shows that firms routinely attempt to identify opinion leaders in online groups and try to enroll them in supporting their brand or using their products (Joshi 2011). For example, firms such as Microsoft and Dell reward the most active participants in newsgroups that discuss their products. However, it is not clear whether the participants thus identified do in fact play leadership roles or to what extent they are influential in shaping the discussions in online communities.

Recent studies have uncovered significant new insights about the structuring of knowledge collaboration in online communities such as the concept of strategic interaction to explain why unequal participation need not have negative consequences (Kuk 2006), the effect turnover has on effectiveness of collaboration (Ransbotham and Kane 2011), and how shaping behaviors contribute to knowledge reuse (Majchrzak, Wagner, and Yates 2013). However, our understanding of the role of leadership in such collaborations is limited. While some behaviors that enable individuals to move from the periphery to the core and manage their activities have been studied in the context of open source communities and Wikipedia (Dahlander and O'Mahony 2011; Fleming and Waguespack 2007; Luther and Bruckman 2008; Reagle 2007), the vast majority of online communities lack the formal role structures and governance mechanisms that are common in such production communities (O'Mahony and Ferraro 2007). Some studies have investigated how centrality and language use impact leadership in online communities; however, these studies rely on data from experiments in a student setting (Sutanto et al. 2011) or deduce leadership *post hoc*, based on secondary data (Huffaker 2010). Therefore, the key question concerning leadership in online communities remains unsettled: Do leaders in online communities engage in specific behaviors that distinguish them from other participants?

Consequently, in this paper, we explore the behavioral and structural antecedents of leadership in online communities. By integrating the behavioral and structural approaches, we provide a framework to outline the factors that relate to being identified as a leader in online communities. Specifically, in the context of online communities such as forums or newsgroups that are devoted to the discussion of various topics, we propose that leadership is associated with the sociability and knowledge contribution behaviors of leaders as well as their structural social capital. Our framework includes leadership nominations by the members as the dependent variable. Using social network analysis, survey, and content analysis measures, we test the above framework using 6,709 messages from 976 individuals gathered from three online communities focused on the discussion of technical topics related to databases and programming. The results largely support our integrated view, suggesting that leader behavioral and structural approaches cannot be used in isolation. This study contributes to both theory and practice by building and testing a model of leadership in a context that has not received enough attention and yet has important consequences for organizations. In the next section we develop the arguments that will inform our theoretical framework.

Theoretical Background

In online communities focused on knowledge collaboration, the primary shared objective is defined by Faraj et al. (2011, p. 1224) as "the sharing, transfer, accumulation, transformation, and cocreation of knowledge," and involves the offering of new knowledge and recombining the knowledge of others. Due to the limited research on leadership in online communities, we selectively adapt ideas from research in different areas for our framework, including leadership in traditional, predominantly face-to-face settings as well as network studies of social and organizational interaction. In the "real" world, a primary aspect of the work of leaders is "influencing others to understand and agree about what needs to be done and how to do it, and the process of facilitating individual and collective efforts to accomplish shared objectives" (Yukl 2006, p. 8).

Online communities provide markedly different environments when compared to traditional organizations due to the geographic distribution of members and the constraints imposed on multifaceted communication by technology mediation. Therefore, it is unclear whether the antecedents of leadership in online communities are similar to those in traditional organizations. First, since participants in online communities rely primarily on text messages to interact with others

(Sproull and Arriaga 2007), communication in online communities lacks the many affordances that make conversations possible in face-to-face interaction, such as social context cues and the establishment of common ground (Clark and Brennan 1991; Cramton 2001; Sproull and Kiesler 1986). Researchers suggest that communication in face-to-face interaction is predominantly nonverbal and paraverbal (Baltes et al. 2002; Kraut et al. 2002; Olson et al. 2002). Knowledge collaboration can be challenging in the absence of such nonverbal affordances and, therefore, researchers have investigated the structures of interaction that enable dialogue in distributed collaborations (Fayard and Metiu 2014; Kudaravalli and Faraj 2008). However, there has been very little research examining how the constraints of mediated communication affect the emergence of leadership in distributed settings in general and online communities in particular (Weisband 2008). For example, in a distributed setting, Weisband (2002) finds that teams where the leader created and maintained awareness of others performed better.

Second, member roles, group boundaries, goals, and tasks are not clearly defined in online communities. Consequently, Faraj et al. (2011) have characterized online communities as fluid objects where boundaries are ever changing and roles are temporary, existing only in the moment. The vast majority of online communities lack the formal role structures and governance mechanisms that are common in other organizational settings (O'Mahony and Ferraro 2007). Participants do not work on assigned tasks with clear goals but respond to the existing needs of the community and thereby create self-defined roles through their volitional activity. Therefore, leadership in online communities is emergent and arises as a result of individual contributions to the community (Dahlander and O'Mahony 2011). In contrast, within traditional organizations, while leadership is emergent in some contexts such as virtual teams (Yoo and Alavi 2004), more often leadership is designated and individuals are appointed to leadership positions. Even when formal roles do exist in online communities, such as listserv owner and administrator, they are often not the ones who make the most significant contributions (Butler et al. 2008). In some online settings, leadership roles are more clearly defined, such as project leader in open source projects and administrator on Wikipedia, even if they are often expertise-based and emergent in practice (O'Mahony and Ferraro 2007; Ransbotham and Kane 2011). However, in a vast majority of online contexts, such as discussion forums, "leadership authority tends to be fleeting" and "roles are not enacted because the participant is a member of a core group or asserts leadership authority" (Faraj et al. 2011, p. 1231). Moreover, participants do not work on definable tasks such as page edits or with identifiable goals such as developing software modules. How can leadership be conceptualized in such settings and what factors lead to someone being considered a leader?

A Theoretical Framework of Leadership in Online Communities

Researchers have identified two kinds of behaviors as important components of knowledge collaboration in online communities. In open source software development, researchers have identified several task-based behaviors such as technical contributions and technical communications as antecedents of lateral authority, a peer recognized form of leadership (Dahlander and O'Mahony 2011). On the other hand, several studies have also highlighted the importance of feedback and specific discursive practices (Moon and Sproull 2008; Orlikowski and Yates 1994). These behaviors broadly conform to a consistent focus in traditional leadership research: the distinction between task-oriented and relations-oriented behaviors of leaders, dating back to the Ohio State and Michigan leadership studies in the 1950s (Yukl 2006). Although studies have used different labels, interest in the primary distinction between task and relations orientation has been prevalent. Later research moved away from a strong distinction between these two types of behaviors with the suggestion that good leaders are not those who display one or another type of behavior predominantly, but rather who show appropriate behavior combining both concerns based on the situation (Blake and Mouton 1982). Therefore, we suggest that both types of behaviors are likely to be important for being perceived as leaders in online communities.

Several studies have found that structural position predicts leadership of knowledge collaboration in online communities (Fleming and Waguespack 2007; Sutanto et al. 2011). In a study of knowledge collaboration in an online group of legal professionals, central members were also found to contribute the most useful knowledge (Wasko and Faraj 2005). In traditional organizations, several studies have highlighted the importance of the structural position of the member in assessing their influence on other organizational members (Brass 1984; Burkhardt 1994; Ibarra and Andrews 1993). However, to occupy central locations in the communication network of the online community, members will need to have been part of the group over time and to have contributed to the discourse. This provides the opportunity for other members in the online community to become familiar with the contributors and recognize their expertise as well as their role in shaping views and sharing knowledge.

Therefore, given the unique context of online communities where task and social behaviors are visible only through

active participation, our theoretical framework emphasizes the dual aspect inherent in message posting. First, there is a need to focus on message content, which we associate with the behavioral approach since it is reflective of actual participant behaviors in the online community. Second, there is a need to evaluate the network that emerges from online interactions and the connections that are generated among participants once a message is posted, which we term the structural approach. Both the behavioral and structural approaches are essential to examine knowledge collaboration and leader behaviors in online communities.

Behavioral Approach

Levine and Moreland (2006) describe the personal qualities associated with effective leadership as those that "involve the ability, sociability, and motivation of leaders. Effective leaders thus tend to be more capable, more socially skilled, and more concerned about their groups than are poor leaders" (p. 348). Given that knowledge collaboration is the primary activity in many online communities, contributing knowledge is likely to be an important behavior for leaders, and corresponds to the task-oriented aspect of leadership in traditional settings. The types of contributions participants make differ based on the expertise of the participant as well as the type of community. In many online communities, especially those focused on knowledge collaboration, leading participants are typically recognized for their contributions of expertise and knowledge rather than for their prosocial behaviors (e.g., Faraj et al. 2011; Lakhani and Von Hippel 2003). For example, in programming related communities, exchanging fragments of programming code is a common practice (Dahlander and Frederiksen 2012; Orlikowski and Yates 1994). In professional communities (e.g., lawyers), expertise-based assessments are highly valued since they incorporate insights gained from participants' experience in practice (Wasko and Faraj 2005). Such knowledge-based assessments, when built upon the contributions of other participants, constitute valuable feedback to the community as a whole (Moon and Sproull 2008). Therefore, task-related knowledge contribution behaviors help establish a participant's reputation as an expert and increase the likelihood of becoming identified as a leader. Consequently, we propose that:

> *Hypothesis 1: Participants with higher levels of knowledge contribution are more likely to be identified as leaders in online communities.*

It is less clear whether being socially engaging when interacting with others in online communities translates into recognition as a leader. While voluntary actions that help others, such as contributing free software, information, and emotional support, have been widely documented in online communities (e.g., Sproull et al. 2005), how sociability affects the evaluation of the help-giver is not fully established. Sociability has long been recognized as a necessary aspect of interpersonal engagement. It is defined by Simmel (1949) as a form of associating with others without ulterior motive or content focus. Researchers have suggested that social linkages in the form of shared activities, touch, informal interactions, and the sustenance of common ground are key factors that make collocated interaction advantageous for collaboration (Kraut et al. 2002; Nardi and Whittaker 2002; Olson et al. 2002).

As a result, most technologies that support online communities are designed to enhance engagement, including multiple features to allow flexible and personalized interactions (Ellison et al. 2011). Promoting sociability is particularly important for the sustainability of online communities, where social interactions are considered crucial for recruiting new members, encouraging participation among members, and sustaining interactions over time (Majchrzak, Faraj et al. 2013; Maloney-Krichmar and Preece 2005; Preece and Shneiderman 2009; Ridings and Wasko 2010). Posts are often evaluated based on their emotional tone and are likely to generate responses that match them in terms of emotional content (Chmiel et al. 2011). Similarly, the simple act of responding to others has been shown to influence the continued participation of new members, even if the response does not answer the newcomer's question (Joyce and Kraut 2006). More broadly, feedback, whether it is task-related or social, has been shown to play a significant role in producing and sustaining high-quality contributions in a variety of online communities (Lampe and Johnston 2005; Moon and Sproull 2008).

While sociability may be important for all online community participants, we argue that it is likely to be even more important for leaders. For example, researchers have found that telling stories and making personal references to other participants constitute specific rhetorical and discursive practices that build legitimacy and authority (Galegher et al. 1998). Community-leading participants have been found to promote social interaction, engage in self-disclosure, and highlight similarities with others, which have been identified as the causes of bond-based attachment in online communities (Ren et al. 2007). In addition, social behavior in language use has been found to predict leaders in online communities (Huffaker 2010), and encouraging other participants to engage in helpful activities was one way in which leaders have been found to promote desirable behavior (Butler et al. 2008). Therefore, we suggest that sociability—by helping establish the social basis of communication in online communities through such practices as thanking and including personal references to

others—is an essential component of the behaviors displayed by leaders in online communities. Therefore, we propose that:

Hypothesis 2: Participants with higher levels of sociability are more likely to be identified as leaders in online communities.

Structural Approach: Social Capital

The popularity of social network analysis has increased the prominence of the structural view of social organization in studies of various social and organizational phenomena (Borgatti and Halgin 2011; Emirbayer and Goodwin 1994; Wellman 1988). Within information systems research, social network analysis is being used extensively to study digital and online social networks (Sundararajan et al. 2013). Broadly, this approach gives primacy to relational ties over individual attributes in explaining social phenomena. Therefore, a structural approach to leadership would emphasize a leader's ties, beyond individual leader characteristics and behavior. The concept of social capital is widely used in such explanations. For example, in explaining inequality, Burt (1999) suggests that "the human capital explanation is that the people who do better are better people (smarter, more attractive, more skilled, et cetera). The social capital explanation is that the people who do better are *better connected*" (p. 48, emphasis added).

The concept of social capital has been widely used in organizational studies (Adler and Kwon 2002). Researchers have suggested formulations of this theory at various levels, such as the individual and collective, communities, organizations, and entire countries. The more expansive uses of the term have been criticized by some researchers as leading to spurious effects (Portes 2000). Interest in this concept as well as the structural view within organizational studies has been renewed for its role in knowledge creation and sharing within firms (Nahapiet and Ghoshal 1998) as well as for studying behavior in newer technology-enabled settings (Steinfield et al. 2008). Social capital has been used to explain knowledge sharing behavior in online communities. For example, Wasko and Faraj (2005), in their study of an online community of legal professionals, find that social capital and the desire to enhance their reputation explain why individuals share their expertise without any expectation of reciprocity.

Social capital is generally defined as the potential resources that individuals or groups have access to by virtue of their networks of relationships, both formal and informal. Although several views of social capital have been proposed, the bridging or brokerage view has been one of the most popular and, given our focus on knowledge collaboration, we focus on this view since it emphasizes the informational aspects of social capital. This view, which is attributed to Burt (1992), is based on the idea of "structural holes." It suggests that actors who bridge parts of the network that are disconnected occupy an advantageous position, which results in positive returns to the actor. The actor spanning the structural hole would benefit from the information arbitrage opportunities offered by communicating with different subgroups that in turn are not themselves connected. In the context of voluntary settings, recent findings have established the link between brokerage and leadership in extra-organizational, open-innovation knowledge communities (Fleming and Waguespack 2007). Therefore, we propose that:

Hypothesis 3: Participants with higher levels of structural social capital are more likely to be identified as leaders in online communities.

Toward an Integrated View

The behavioral and structural approaches emphasize different factors that underlie leader behaviors in online communities. While the behavioral approach is leader-centric, focusing on the skills, behaviors, and expertise of the leader, the structural approach highlights the position of the leader and the ability to channel information flows in the context of the wider community. Clearly, a better understanding of leadership necessitates combining both emphases. A long-standing criticism of leadership research has been that most studies adopt a narrow focus and are limited to a particular formulation. Therefore, researchers have called for a more integrative approach that takes into account individual and contextual variables in studying leadership (Yukl 2006, p. 15).

Researchers adopting the structural approach have echoed similar concerns. Specifically, researchers have suggested that the strength of the social network perspective is its ability to argue for the "priority of relations over categories" (Emirbayer and Goodwin 1994, p. 1414). On the other hand, researchers have also pointed out the limitations of the more deterministic structural approaches in explaining complex social phenomena (Emirbayer and Goodwin 1994). For example, Kilduff and Tsai (2003) call for more attention to action in social network studies and propose a post-structuralist perspective focused on what individuals do, characterized by "bringing the subject back in as active agent engaged in the structuring of networks through action and perception" (p. 114). Similarly, Sundararajan et al. (2013), in their review of digital networks, call for more research that

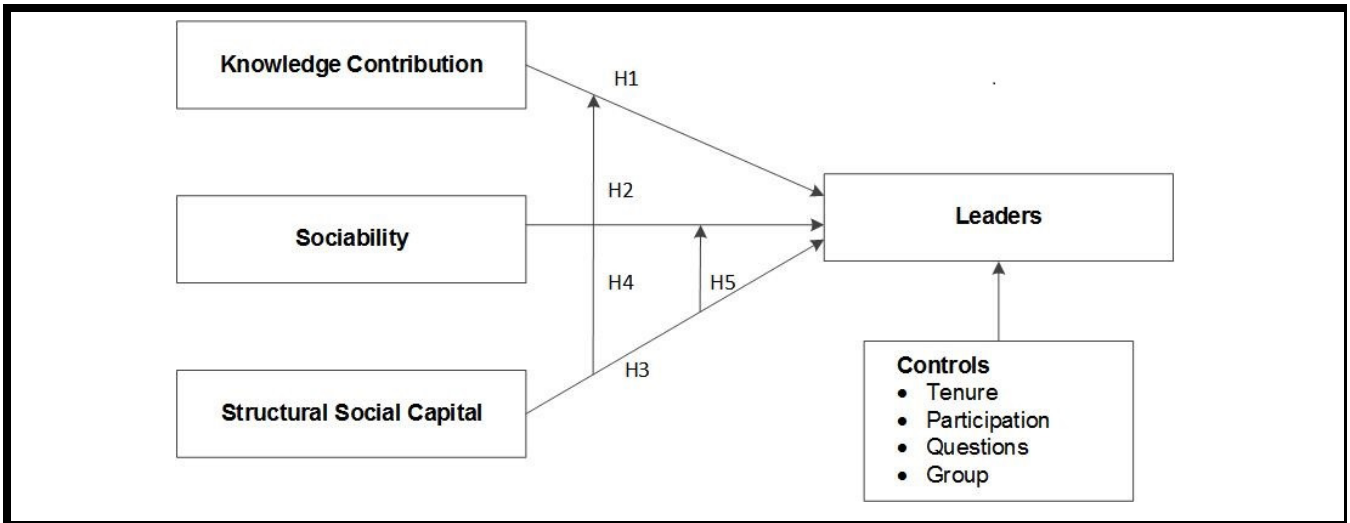

Figure 1. Theoretical Model

takes into account the content flowing through the networks. However, despite these calls, very few studies adopt such integrative approaches in studying leadership specifically, or organizational phenomena in general.

In the context of online communities, we argue that both approaches are essential to understanding leadership. Previously, we suggested that participants who occupy central positions in the overall communication network structure of the online community would be identified as leaders. According to this view, participants who span structural holes in the online community are better positioned to benefit by forming bridges between disconnected groups. Since the disconnected groups are likely to have access to different kinds of information, potential leaders who act as brokers between groups are in a position to trade on this novel information. However, the potential inherent in the structural position of brokers will not be realized unless participants contribute novel information to the relevant group. Studies show that people who have unique information and experiences are more motivated to contribute to online communities (Wasko and Faraj 2005). Both in light of their access to different kinds of information as well as the need to realize the structural benefits of their position, brokers are likely to contribute more knowledge in online communities. In essence, it is not just network position that matters but also how much one actually contributes knowledge to the community. Consequently, we posit:

> *Hypothesis 4: Structural social capital moderates the relationship between knowledge contribution and being identified as a leader in such a way that the relationship is more positive when structural social capital is high than when structural social capital is low.*

Beyond task focus, "leaders who show sociability are friendly, outgoing, courteous, tactful, and diplomatic. They are sensitive to others' needs and show concern for their well being" (Northouse 2012, p. 18). Thus, the tenor of the message received from a participant with high structural social capital is more likely to be noted compared to that of messages from low ranking others. Since communication in online communities is entirely textual and limits the social context cues that characterize face-to-face communication, sociability plays an important role in participant interactions as described earlier. Wasko and Faraj (2000), using 342 open-ended responses to the question of why individuals participate and contribute in an online community, found that there was a strong prosocial orientation generated from membership in the community. Another survey of 663 online community participants found that the perceived responsiveness of others and trust in others' benevolence were predictors of willingness to exchange knowledge (Ridings et al. 2002). Indeed, norms of reciprocity are often essential to sustain online communities (Faraj and Johnson 2011; Ren et al. 2012). Therefore, structural social capital and sociability jointly affect how communications are experienced by participants. Given the threat of social distance in mediated communication, demonstrating active commitment to the community and to one another has been put forth as the main way by which successful collaborations can be maintained (Kiesler and Cummings 2002; Orlikowski and Yates 1994). Therefore, participants high in structural social capital in

addition to high levels of sociability are more likely to be identified as leaders in online communities. Consequently, we posit

> *Hypothesis 5: Structural social capital moderates the relationship between sociability and being identified as a leader in such a way that the relationship is more positive when structural social capital is high than when structural social capital is low.*

Methods

Sample

We gathered data from three different Usenet newsgroups for this study. Started in 1979, Usenet is one of the earliest online communities on the Internet and allows participants to gather and discuss issues related to common interests from anywhere in the world (Kollock and Smith 2002). By 2005, there were at least 189,000 newsgroups that catered to a wide range of interests (Wang et al. 2012). As with many online communities nowadays, participation is voluntary, open to the public and participants are not required to sign-up to become members, so that "individuals become visible only when they post messages" (Wang et al. 2012). The majority of the newsgroups in Usenet are unmoderated, so messages posted by the participants are immediately broadcast to all participants of the newsgroup. Given the lack of formal structures or hierarchies, it is an ideal setting to investigate leadership in online communities. Since our interest is in studying various types of participant behaviors, but emphasizing knowledge collaboration, we chose three unmoderated newsgroups focused on the discussion of technical issues related to object-oriented programming, databases, and c++ programming.

The operationalization of the variables in the model involved the collection of data in three ways: content analysis of message postings, social network analysis, and survey responses. We saved all of the messages posted to the three newsgroups for a period of 50 days. Across the three newsgroups, 6,709 messages were collected and the data was aggregated to the individual level, for a total of 976 participants. We then sent each of the participants a survey via e-mail to collect the data assessing the dependent variable—leaders. The response rate for the entire study was 24 percent. As a check for non-response bias, we compared posting activities between individuals who responded to our survey and those of non-respondents. The participation rate of people who responded to the survey was not significantly different from that of non-respondents ($F = .516$, n.s.).

Content Analysis Procedure

Our knowledge contribution and sociability variables were assessed by analyzing the content of message postings and rating the postings for the items listed in Table 1. We iterated between inductive and theory driven approaches in creating the coding scheme for the content analysis of individual messages (Krippendorff 2012; Weber 1990). The two dimensions of sociability and knowledge contribution were identified as being important to becoming recognized as a leader based on an examination of how such behaviors were exhibited in several online communities and also how they were operationalized in prior studies (Galegher et al. 1998; Orlikowski and Yates 1994). By cycling between previous operationalizations and our specific context, we arrived at a an initial coding scheme with the resulting items for each dimension. These dimensions were evaluated by the authors and several graduate students and the categories were further refined. We eliminated the categories that seemed ambiguous or unclear, resulting in the final coding scheme as shown in Table 1. To test for the reliability of the content analysis codes, two of the authors independently coded the same 100 messages for all the items that were used. Reliability was calculated using Cohen's kappa statistic, which is widely used for such measures. The kappa statistic ranged between 0.7 and 0.9 for individual items, which is considered good (Banerjee et al. 1999).

Measures

Knowledge Contribution: This variable is indicative of the task-oriented behaviors of participants. Since the Usenet newsgroups included in this study are focused on the discussion of practice-based technical topics, such behaviors included providing answers to questions posed by the other members as well as providing assessments based on their technical or professional expertise. Sometimes the answers also included programming code. Knowledge has been classified in the literature into several categories. The items that are used as indicators of knowledge contribution combine elements differentiating between declarative and procedural knowledge, a common distinction in the literature (Brown and Duguid 1998). Therefore, as shown in Table 1, the knowledge contribution variable measured declarative and procedural information, code contributions, and professional assessments. These categories have been used in prior literature examining knowledge collaboration in online communities (Dahlander and O'Mahony 2011; Orlikowski and Yates 1994; Wasko and Faraj 2005).

Sociability: The sociability variable captures behaviors aimed at building relational engagement with others (see Table 1 for

Table 1. Description of Variables

Construct	Variable	Description
Leader	Identified Leader	Number of times the individual has been identified by other group members as a leader. Members of the newsgroup answered the following question on the survey: "Please identify three people who are leading members of this Newsgroup (please give either their full name or e-mail address)."
Controls	Tenure	Tenure was gathered from the survey with the following question: "How long have you been a member of this Newsgroup? ___months"
	Participation	Total number of messages posted by the member.
	Questions	This indicates whether the posts was a request for information
Knowledge Contribution	Procedural Information	Refers to a specific technical procedure "Does anyone know how to..." Procedural information outlined procedures, steps or methods to accomplish a task. These could include detailed step-by-step instructions or description of major phases or heuristics to help solve a problem. (0,1)
	Declarative Information	Refers to a specific technical knowledge "Does anyone know what..." In contrast to procedural knowledge, this type of knowledge is declarative or factual. Examples in the email messages coded as declarative include such information as naming books, people, reference articles, announcements, etc. (0,1)
	Code	Post includes programming code (0,1)
	Assessment	Whether the message includes an assessment (opinions or interpretations), based on technical expertise (opinion based on expertise about features/advantages/ disadvantages relating to the technology) or professional expertise (opinion based on expertise about the profession or community as a whole). (0,1)
Sociability	Sign-Off	Social goodbye, thank you, or other social form of sign off. (0,1)
	Thanks	A specific thanks for receiving help. (0,1)
	Story	This indicates the extent to which the post came from personal experience (0,1)
	Personal Aside	This indicates that the post had a personal aside to a specific member (for example, by referring to someone by their first name) (0,1)
Structural Social Capital	Bridging	Betweenness centrality

more details on the variable operationalization). In our setting, the messages included seed messages with questions or comments, and subsequent discussion messages. When questions were answered or information was contributed, participants often thanked others. Following the approach used by Constant et al. (1996), we coded messages for sign-offs, anecdotes, thanks, and personal stories. These acts of sociability have been used in prior research that has studied communicative practices in online communities (Constant et al. 1996; Galegher et al. 1998; Orlikowski and Yates 1994).

Structural Social Capital: The bridging mechanism by which structural social capital operates for leaders in online communities is represented by betweenness centrality, which has been widely used in prior research (Huffaker 2010; Mehra et al. 2001; Sutanto et al. 2011). This measure is an indication of the degree to which a participant is in the "middle" of the communication between various members in the group (Freeman 1979; Wasserman and Faust 1994). To calculate betweenness centrality, we used information gathered from individual message headers to construct a matrix consisting of ties between who responded to whom in the online community. In line with the methods used in prior research, a directed tie was recorded in the matrix when a message was posted as a direct response to the author of a prior message (Wasko and Faraj 2005). We used UCINET 6 (Borgatti et al. 2002) to generate the measures of centrality. We considered several alternative centrality measures such as closeness and eigenvector, but chose betweenness because it is most similar to the conception of leader influence in online communities, considers indirect ties, and has been widely used to measure bridging social capital (Shaw et al. 2005). This measure of centrality, estimated by Freeman (1979), assesses the sum of the probabilities that an actor i is involved in the communication between two actors as follows:

$$C_B(n_t) = \sum_{j<k} g_{jk}(n_i) / g_{jk}$$

Dependent variable: The dependent variable in the model is identified leader, as indicated by the recognition of a participant as a leader in the Usenet newsgroup by other participants. Survey respondents rank-ordered up to three participants that they considered to be leaders in the online community (see Table 1 for the survey item). These open-ended survey responses were then aggregated for each individual to arrive at a count variable, which formed our dependent variable. In other words, this variable is operationalized by adding up the number of times the said participant is identified by others as a leader. The nomination approach through open-ended questions has been used in previous studies to identify leaders in technology- enabled settings (Sutanto et al. 2011; Yoo and Alavi 2004). A total of 42 participants were identified in our sample as leaders from 318 responses. Of these, 20 participants were identified as leaders once, 8 participants were identified twice, 4 participants were identified three times, and 2 participants were identified four times. Only the remaining 8 participants were identified nine or more times, with the person who was identified most often receiving 90 responses. Self-nominations were not accepted. The remaining 934 participants in the sample did not receive any nominations. It is clear, therefore, that the identification of leaders is a highly concentrated event. Predicting such events presents several methodological challenges that are discussed in the analysis section.

Control Variables: We included tenure in the online community and total participation as control variables (explained below) in order to be able to identify specific leader behaviors over and above simple posting activity and length of time in the online community. Tenure is included to control for the possibility that only long-standing participants were identified as leaders by default, as they may be more recognizable. Similarly, total participation was included to control for the possibility that the most visible members were identified as leaders. Tenure data was gathered from the survey by asking how many months respondents had been participants in the online community (see Table 1 for the item). Participation was operationalized as the total number of messages posted by the respondent in the observation period. Both variables were transformed using a log transformation due to skewed distributions. Since our sample included three different Usenet newsgroups, we included two dummy variables called Group 2 and Group 3 to control for the potential group effect. Finally, we controlled for the possibility that knowledge seekers instead of knowledge contributors would be identified as leaders.[2] We coded a variable called "Questions" for each message to indicate whether the post was a question. When aggregated to the individual level, it represents the propensity of that participant to ask questions.

Data Aggregation

Individual messages were coded for knowledge contribution and sociability behaviors and then aggregated to the individual level. First, each message was coded for the existence of the four types of knowledge contribution and the four types of sociability listed in Table 1. We calculated the mean for each participant across all of their messages for each of these contribution behaviors. In other words, we totaled the scores for each type of knowledge contribution and sociability behavior listed in Table 1 across all messages for each individual and then divided by the total number of messages by that individual. This resulted in our formative indexes, which represent the mean knowledge contribution and sociability behavior of each individual.

For example, consider the several examples of message excerpts for the different knowledge contribution and sociability categories we present in Appendix A. Using the coding scheme in Table 1 and following the content analysis procedure outlined in a previous section, an independent rater assessed each message for all of the categories. Whenever a message or part of a message, such as the ones shown in Appendix A, matched the criteria defined in Table 1 for each item, that particular item received a score of 1. After all messages were similarly evaluated and scored for all of the items, the knowledge contribution and sociability variables were calculated by adding the scores for each individual for all items across all of the messages posted by that individual and then dividing by the total number of messages posted by that individual.

Analysis Approach

Our dependent variable is a count of the number of times a participant was identified by another participant in the community as a leader. We aggregated the total number of responses received by each individual into a count variable. Traditional regression models using ordinary least squares (OLS) are biased and inconsistent when the dependent variable is measured as counts (Cameron 2005). Poisson models are often employed in such cases. In our specific case, the data shows evidence of overdispersion: the variance of the dependent variable is substantially larger than its mean, as shown in Table 2. We confirmed overdispersion in the data using tests recommended in the literature such as the alpha test and the likelihood ratio test (Cameron and Trivedi 2013; Long 1997). When the data are overdispersed, the stan-

[2]We thank the anonymous reviewer for this insightful observation.

Table 2. Descriptive Statistics

	Variable	Min	Max	Mean	S.D
1	Tenure in Months	0.0	120	15.56	20.29
2	Participation	0.0	260	3.92	13.79
3	Questions	0.0	1	0.42	0.47
4	Group 2	0.0	1	0.23	0.42
5	Group 3	0.0	1	0.58	0.49
6	Knowledge Contribution	0.0	3	1.13	0.60
7	Sociability	0.0	2	0.50	0.53
8	Structural Social Capital	0.0	21	0.21	1.09
9	Identified Leaders	0.0	90	0.31	3.72

dard errors in Poisson models are biased downward and, therefore, negative binomial models are preferred (Cameron and Trivedi 2013).

However, another characteristic of our data is that very few participants in our sample were identified as leaders. Of the total sample of 976 participants, only 42 individuals received responses whereas 934 individuals received none; most participants have a count of zero for the dependent variable. When standard negative binomial regression is used for such data, it will under-predict the zero counts. To counter the effects of excessive zeros in our model we used the zero inflated negative binomial (ZINB) regression. ZINB models account for the difference between mean and variance and also add more predictions of zeroes (Long 1997). This is done by assuming that the population consists of two separate latent groups: those who have a chance of being identified as a leader (group A) and those who don't (group B). The counts are generated by two separate processes to reflect the low probability that an online community participant who posts very few messages would be identified as a leader.

The ZINB model allows each observation to have a positive probability of being part of either group. Thus, for each observation *i,* group A is chosen with a probability of λ_i and group B is chosen with a probability of $1 - \lambda_i$. Group A only generates zero counts and group B generates positive counts represented by $f(y_i \mid X_i)$. Thus the decision rule can be formally stated as follows:

$$y_i \begin{cases} 0 & \text{with probability } \lambda \\ f(y_i \mid X_i) & \text{with probability } (1-\lambda_i) \end{cases}$$

The probability of $(Y_i = y_i \mid X_i)$ can be formally expressed as follows:

$$P(Y_i = y_i \mid X_i, Z_i) = \begin{cases} \lambda(\alpha Z_i) + [1-\lambda(\alpha Z_i)] f(0 \mid X_i) & \text{if } y_i = 0 \\ [1-\lambda(\alpha Z_i)] f(y_i \mid X_1) & \text{if } y_i > 0 \end{cases}$$

Where the probability λ_i depends on characteristics (Z), which influence the inflation of zeros. The probability λ_i can then be estimated using any discrete choice link function such as the probit or the logit. Therefore, two separate models are used to account for the two distinct latent processes. First, a binary model, also called an inflation model, which can be either a logit or a probit model, is used to predict zeroes, or membership in the group that has not been identified as leaders. Second, the negative binomial regression model is used to predict the count of leader nominations. This model is also called the count model.

Finally, we performed a number of additional analyses for robustness checks as well as to test the appropriateness of the analysis procedure. First, we performed a standard negative binomial regression model to establish the baseline for our chosen approach (Long 1997). Second, what variables are chosen as predictors in the inflation model depends on the theoretical rationale. As outlined in the description of the control variables, we think that tenure and participation should be included in the inflation models to predict membership in the group that does not provide a chance of being identified as a leader, since there is likely a threshold level of tenure and participation that is required for participants to be considered leaders. However, we also tested whether additional variables have an impact in these models. The additional variables added to the inflation part were not significant. The results support the justification given earlier for including only the control variables in the inflate models. In addition, the model statistics showed no appreciable improvement with the inclusion of these variables and the results did not differ in any significant way from those presented in Table 2. Finally, we also formally tested whether the zero-inflated models fit the data better than the standard negative binomial regression using a non-nested model testing procedure, the Vuong test (Vuong 1989). Generally, a value greater than the critical value of 1.96 for this statistic would

suggest a preference for the zero-inflated model (Long 1997). For our models, the lowest statistic for the Vuong test was 2.68. Therefore, the Vuong test indicates that all of the models presented here provide a better fit than the standard negative binomial models.

Results

Table 2 presents the descriptive statistics for the variables used in the analysis, including means and standard deviations. Table 3 presents the correlations. The correlations are below the levels that would indicate problems with collinearity (the highest VIF statistic was 3.92, below the acceptable level of 5) (Belsley et al. 2004). We centered our predictor variables in order to aid the interpretation of interaction terms as well as reduce multicollinearity. Table 4 shows the results for the ZINB analysis, which addresses the problem with excessive zeroes in the dependent variable, as described earlier. Variables were added in a step-wise fashion to the models. Steps 1, 2, 3, and 4 are listed in separate columns in the table. Variables added in Model 1 represent the control variables. In Model 2, the leader behavioral variables of knowledge contribution and sociability were added. In Model 3, we added the structural social capital variable, while keeping the behavioral variables from Model 2. Finally, in Model 4, the interaction terms were added to test the interaction between the behavioral and structural social capital variables. In addition, Models 1 through 4 for ZINB regression include both the count and inflate (at the bottom of the table) models described in the previous section. The control variables are included in both the count and the inflation model for all three models (Long 1997). As described earlier, since the inflation model predicts zeroes or membership in the group that does not provide a chance of being identified a leader, the variables included in this model are the control variables of participation and tenure. Counterintuitively, these control variables are used to identify participants who do not have the potential of being identified as leaders. Therefore, in the inflation models, participation and tenure are negatively associated with being designated as someone who does not have the potential of being identified as a leader. Alternatively, as participation and tenure in the group increases, the potential of the participant for being recognized as a leader increases.

First, as the inflate part of all three models shows, tenure and participation are highly significant and, therefore, strongly predict membership in the group that does not provide a chance of being identified as leaders. In addition, participation is highly significant in the control variables model, showing that participation is necessary for someone to be identified as a leader. Second, while tenure and participation are positively associated with being identified as a leader in some models, the number of questions asked by a participant has a strong negative association. This shows that a leader is more likely to provide answers than ask questions. As shown in Table 4, the ZINB regression predicting leaders from tenure, participation, questions and group (Model 1) was statistically significant. The addition of the behavioral variables of knowledge contribution and sociability in Model 2 improves the model statistics (log likelihood = -202.783, Wald $\chi^2 = 78.784$). Further, while the knowledge contribution variable was found to be significant, sociability was not. Therefore, hypotheses 1 finds support, but not hypothesis 2. The addition of structural social capital in the next step improved the model statistics further (Model 3), as indicated by the decrease in scores of log likelihood (-196.153) and Wald test (95.591) and, therefore, hypothesis 3 also finds support. Finally, the interaction terms were added in Model 4 to test the impact of leader behaviors when combined with structural social capital. As shown by the model statistics (log likelihood = -194.543, Wald $\chi^2 = 343.462$) and the significance of the interaction terms, hypotheses 4 and 5 are strongly supported.

To interpret the coefficients in Table 4, we calculated the percentage change in expected count of leader identifications. For example, in Model 3, we find that for one standard deviation increase in knowledge contribution, sociability, and structural social capital, the expected average number of times a leader is identified by others increases by 67.3 percent, 12.5 percent, and 34.1 percent, respectively. To further analyze the impact of the independent variables on the likelihood of being identified a leader, we computed their marginal effects (Scott and Freese 2005). Our marginal effects analysis showed that the expected leadership identifications increased, on average, by 1.2 for knowledge contribution, by .54 for sociability, and by .1 for structural social capital. Therefore, knowledge contribution has the most likelihood of increasing the number of times a leader is identified by others.

Finally, in order to interpret the interaction effects reported in Table 4, we graphed the interactions between knowledge contribution, sociability, and structural social capital (Scott and Freese 2005). Figure 2 shows the interaction between knowledge contribution and structural social capital. It shows that while at low levels of structural social capital, knowledge contribution has a slight positive effect on being identified as a leader, it produces a sharp increase when structural social capital is high. Similarly, Figure 3 shows the interaction between sociability and structural social capital, and indicates that while the effect of sociability on leadership is nearly flat at low levels of structural social capital, sociability is quite beneficial when structural social capital is high.

Table 3. Correlations

	Variable	1	2	3	4	5	6	7	8
1	Tenure in Months (LN)								
2	Participation (LN)	0.168***							
3	Questions (LN)	0.264***	0.278***						
4	Group 2	0.108***	0.191***	0.100**					
5	Group 3	-0.006	0.085**	0.075*	-0.646***				
6	Knowledge Contribution	0.036	0.101**	0.081*	-0.184***	0.148***			
7	Sociability	-0.094**	-0.099**	0.369***	0.087**	-0.038	0.108***		
8	Structural Social Capital	0.092**	0.482***	0.108***	0.024	-0.143***	-0.028	0.025	
9	Identified Leaders	0.118***	0.320***	-0.076*	-0.042	-0.052	-0.019	0.031	0.721***

N = 976, *p < 0.05, **p < 0.01, ***p < 0.001

Table 4. Zero Inflated Negative Binomial Regression of Identified Leaders

	Model 1	Model 2	Model 3	Model 4
Control Variables				
Tenure in Months (LN)	0.178 (0.266)	0.357 (0.212)	0.338* (0.156)	0.353* (0.144)
Participation (LN)	0.529*** (0.128)	0.518*** (0.122)	-0.066 (0.201)	-0.121 (0.185)
Questions (LN)	-3.984*** (1.029)	-3.600*** (0.923)	-3.128*** (0.648)	-2.828** (0.607)
Group 2	-0.579 (0.559)	-0.325 (0.484)	-0.372 (0.446)	-0.549 (0.417)
Group 3	0.312 (0.546)	0.362 (0.535)	1.251* (0.529)	1.238* (0.539)
Independent Variables				
Knowledge Contribution		0.952* (0.477)	0.859** (0.302)	0.680* (0.302)
Sociability		-0.125 (0.637)	0.224 (0.650)	-0.379 (0.653)
Structural Social Capital (SSC)			0.265*** (0.072)	0.245*** (0.053)
Interaction Terms				
Sociability × SSC				0.193** (0.064)
Knowledge Contribution × SSC				0.276* (0.140)
Constant	-5.500*** (1.143)	-5.935*** (1.061)	-4.769*** (0.785)	-4.434*** (0.868)
Inflate				
Tenure in Months (LN)	-0.608** (0.202)	-0.527* (0.217)	-0.532* (0.217)	-0.521* (0.215)
Participation (LN)	-0.990*** (0.180)	-0.949*** (0.181)	-1.048***	-1.068*** (0.178)
Constant	4.543*** (0.818)	4.136*** (0.886)	4.790*** (0.911)	4.838*** (0.910)
Log Likelihood	-204.580***	-202.783***	-196.153***	-194.543***
Wald χ^2	61.587	78.784	95.591	343.462

N = 976, robust standard errors in parentheses. *p < 0.05, **p < 0.01, ***p < 0.001.

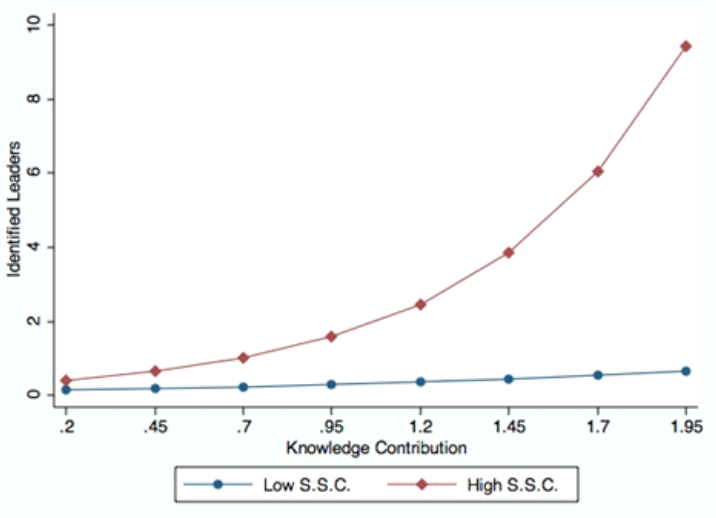

Figure 2. Effect on Leader Identification of the Interaction between Structural Social Capital and Knowledge Contribution

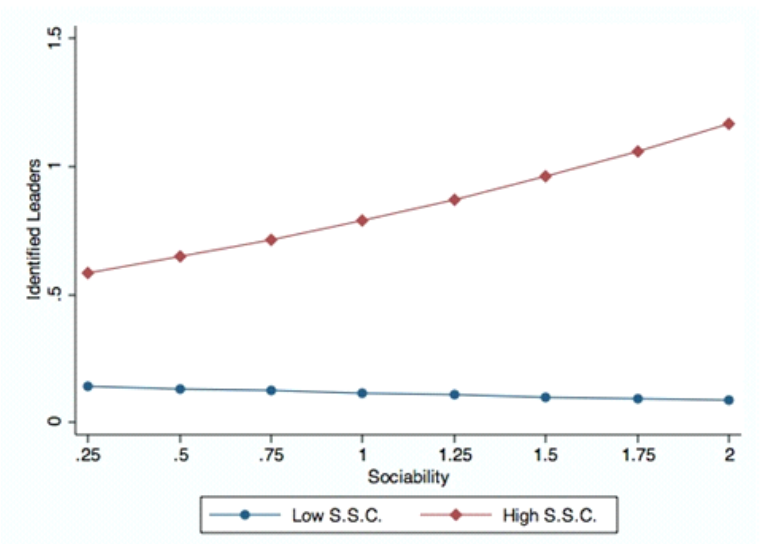

Figure 3. Effect on Leader Identification of the Interaction between Structural Social Capital and Sociability

Discussion

In the preceding sections, we developed and tested a model of leader behaviors in online communities. We hypothesized that becoming identified as a leader is dependent not only on the extent of knowledge contribution and sociability, but also on structural positioning in the communication network. The first finding of our study is that sociable behavior in itself is not associated with being identified as a leader in online communities. The emerging research on leadership in various technology-enabled settings highlights differing leader behaviors. While knowledge contribution behavior was associated with leadership in open source projects (Dahlander and O'Mahony 2011; O'Mahony and Ferraro 2007), sociable

behavior in language use such as talkativeness, affect, and linguistic diversity was associated with leadership in Usenet newsgroups (Huffaker 2010). Our study shows that, to be recognized as a leader, it is not enough to post messages or be sociable; one must also contribute to the community's central task, in our case, dialoguing about technical topics. At least in online communities where the focus is on knowledge collaboration, high participation and sociability may not be sufficient for one to be recognized as a leader.

Second, identifying individuals who occupy central positions in the network has been a common approach to predict online leaders (Huffaker 2010; Sutanto et al. 2011). Our study shows that, while structural social capital is associated with the identification of leaders, the likelihood of a central participant being identified a leader is significantly greater if they also exhibit knowledge contribution and sociable behaviors. This explanation sheds light on another contradictory finding in the literature on leadership in virtual settings. Yoo and Alavi (2004) found that relations-oriented behavior did not differentiate emergent leaders, whose communication was characterized by task-oriented messages. This finding appears to contradict not only the literature in online communities that shows the importance of social behavior as a way to overcome the limitations of mediated communication and the absence of context cues (Huffaker 2010; Moon and Sproull 2008; Preece 2000; Ren et al. 2007), but also traditional leadership research, which has established the importance of relations-oriented or person-focused behavior through numerous studies (Burke et al. 2006). Our study offers another explanation: even though sociability does not predict identification as a leader, actors who are central in the communication network and exhibit greater sociability are more likely to be recognized as leaders. In other words, socially oriented behavior does not lead to someone being identified a leader but, all things being equal, sociability by highly central participants leads to increased recognition as a leader.

A third contribution of our study is the examination of the distribution of leadership in online communities. Even as empirical evidence is lacking, current views paint a largely egalitarian picture of online communities, as evident from the choice of the labels used to describe them: *online community* (Faraj et al. 2011; Sproull and Arriaga 2007), *lateral organizations* (Dahlander and O'Mahony 2011), or *electronic networks of practice* (Wasko et al. 2004) to name a few. Some observers have even suggested that leadership is nonexistent in these new organizational forms and that characteristic is, moreover, their strength (Brafman and Beckstrom 2006). In contrast to such views, we found that leadership is highly relevant for knowledge collaboration in online communities, based on the significant number of responses (over 300) received from respondents. On the other hand, being identified as a leader by others was distributed across relatively few participants (42), with the top few receiving a disproportionately large share of the responses: only 8 participants were identified 9 or more times, with the most-identified person receiving 90 responses. This suggests a high level of consensus among the participants in their recognition of leaders in the community. This concentration appears to contradict the finding from recent research that suggests that new organizational forms are characterized by shared or distributed leadership among members (Pearce 2004; Zhu et al. 2012). One possible reason for the concentration in our study may be that, to be considered a leader in these online communities, given their technical focus, individuals have to acquire significant experience and expertise and, therefore, fewer participants qualify. This seems to be supported by the findings from studies of practice-based communities in organizational settings, where a small, core group provides leadership and engages in mentoring activities (Lave and Wenger 1991). Therefore, how leadership is distributed in different types of online settings is a fruitful avenue for future research.

Our results seem to suggest greater caution in using the proliferation of trace data to study online interaction. Without examining the content of communication, our research is likely to result in severely under-socialized accounts. For example, preferential attachment, a structural feature that has been widely documented in a variety of physical and technical networks, has been found to explain less of the dynamics of online communities compared to reciprocity and generalized exchange mechanisms (Faraj and Johnson 2011). Sundararajan et al. (2013), in their outline of new directions in research in digital and social networks, note that network studies often do not take into account the information that is flowing through them and call for more research. Therefore, in this study, we analyze the content of the messages to extract behaviors exhibited by leaders and find that participants who occupy advantageous positions in the network are more likely to be identified as leaders if they exhibit specific behaviors. Therefore, both behavioral and structural attributes need to be considered in the examination of online communities.

Our study has implications for practice in terms of how to manage online communities. Given the ever-increasing role of user involvement in organizations (Joshi 2011), online communities have become extremely influential in determining how the firm's products are received in the marketplace as well as offering insights that can be helpful in product development. For example, anecdotal evidence suggests that blogs and forums can offer an early read on

changing public tastes to interested organizations, allowing them to anticipate and react more quickly to market demand (Levingston 2006). Therefore, firms try to shape these discussions by identifying influential participants and rewarding them. However, our study points to the difficulty of such efforts given the multidimensional nature of leadership in online communities. Leaders emerge from long-term engagement with the community, contribute significant knowledge, and, as central actors, tend to distinguish themselves through sociable behavior. Such a complex set of characteristics is likely to be difficult to affect and change, and leadership is, therefore, best left to emerge naturally. Other studies also support such a view. For example, for managing and developing communities of practice in face-to-face settings, Thompson (2005) recommends seeding structures and describes the negative consequences of traditional or controlling structures. Nevertheless, our study improves the understanding of practitioners by identifying the specific behavioral and structural variables that predict leadership—in particular, the different kinds of knowledge contribution and text-based sociable behavior, as well as the specific type of structural location of the leader in the community.

Like all empirical investigations, this study has limitations. One limitation is that this study is based on three specialized technical discussion forums and, therefore, the generalizability of the results may be limited. Future research can explore these findings in other settings. For example, while the leadership in our knowledge-oriented online communities was concentrated, in recreational or leisure-oriented communities, leadership may be relatively more diffused. Moreover, research is needed to investigate not only other types of knowledge or social communication, but how specific individual attributes shape leadership perception as well. A second limitation is the cross-sectional design of our study. We cannot comment, for instance, on the process of leadership emergence or whether the specific sociable and knowledge contribution behaviors led to the leaders' structural position or vice versa. A third limitation of our study is related to our measurement approach. Since we use message data to construct the social network, if participants communicated outside the newsgroup, those interactions are not captured in our data and could conceivably influence who is identified as a leader. Similarly, our behavior variables are derived from content analysis and are, therefore, rudimentary, even though they are supported by previous studies and we used multiple raters to ensure reliability. Future research can build on these items to develop more fine-grained measures of online behavior. In addition, these measures can be supplemented with objective measures, especially those related to assessing the necessarily subjective evaluation of knowledge contribution.

By establishing the relevance of leaders in online communities, our study opens up multiple avenues for interesting future research. An open question relates to the kind of leader behavior that can be sustained in online settings. Just like in face-to-face settings, it stands to reason that online communities could sustain multiple forms of leadership. More precisely, what leader attributes or styles apply online? Do certain online communities favor a more directive style as opposed to the more empowering leadership style we saw here? What additional dimensions of leader behaviors are important and why are they necessary to sustain online communities? For instance, Denison et al. (1995) suggest eight different leadership roles, such as the innovator role, the producer role, the director role, etc. The focus of this research was to gain a better understanding of the leadership behavior related to the broker role, and the importance of positioning oneself as a central actor in the discussion network. Future research should further examine leadership roles in online communities and how individuals exhibit these role characteristics through online interactions.

Future research should also examine leaders in different types of online communities. We chose to focus on leaders in one specific type of online community: Usenet forums. Other kinds of online communities such as wikis, blogs, social networking sites, or massively open online games/courses may exhibit different leader behaviors when compared with Usenet forums. Some online communities have formal roles and it is not clear how occupying a formal role, let's say that of a moderator, translates into being identified as a leader. An interesting question is the importance of history given the high turnover in most online communities. Does the list of leaders change constantly? Is there a memory effect, or is a leader online just an ephemeral moment of recognition that dissipates quickly if she stops posting for a few days? Further, we know little about the impact of the technology infrastructure on leadership. Some forums like the ones studied here rely on a threaded discussion technology infrastructure. Other forums have mechanisms to vote on the value of contributions and "up" them. Thus, how different features of technology enable or constrain leader behavior in online communities remains an open question that needs further investigation. Finally, we note the dearth of studies that have followed the life of an online community longitudinally. It would be of great interest to follow a community through the different phases of its evolution and evaluate the associated leadership roles and behaviors as they develop over time.

In conclusion, this study has explored how participants' online activity could lead to being identified as a leader in open-membership online communities. We suggested the

existence of several sources of leader behaviors that are relevant to online communities. Those participants who develop structural social capital, who provide knowledge contributions relevant to the group's mission, and who exhibit a high degree of sociability are likely to be named as group leaders. Our study contributes methodologically via its multifaceted approach of using content analysis to bring into consideration actual message content, network analysis of the communication network, as well as identification of leaders through survey responses. Our results show that leadership online is multidimensional, with characteristics that differentiate it in important ways from leadership in traditional, offline settings.

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Appendix A

Examples of Content Analysis Categories

Knowledge Contribution	
Procedural Information	"Using EXPLAIN PLAN will help here since you will have a better handle on performance. One other thing you should do is to run the ANALYZE command against the tables accessed in your statement as your first step in developing your statement." "How about each piece class knowing how it moves, but another class, perhaps the board, or a class like your active object class, is responsible for moving the piece? This class would receive a command (or message) to move a particular piece, ask the piece how it will move, check which moves are actually possible…"
Declarative Information	"The best way to solve your problem is to use the Pattern Bridge, specified in the book : 'Design Patterns, Elements of Reusable Object Oriented Software, by Erich Gamma, Richard HElm, Ralph Johnson and John Vlissides' "In the MSDN Library I came upon this word of advice regarding heap allocation: 'The system provides no memory protection for memory objects on the heap. It also does not compact the heap…'
Code	"An outer join is what you need. SELECT * FROM CUSTOMS Cu LEFT OUTER JOIN CHILD Ch ON (Cu.NUMBER = Ch.NUMBER)" "getline (cin, address_line_1, '\n'); This will read from the cin stream, into the variable address_line_1 until it hits a newline character (which it throws away)."
Assessment	"There are virtual functions, and there is virtual inheritance. There is no such thing as virtual base classes. The virtuality in that case is an attribute of the inheritance relationship, not the base class." "As I read it, they are not distinct operators, but are different ways of spelling the same operator. operator &&() is the same thing as operator and()." "I'll bet a nickel the problem is in part of the code you did not post. My guess: you forgot to open the file in binary mode."
Sociability	
Sign-Off	"I hope this is helpful." "Good luck."
Thanks	"P.S. Special thanks for _____ who tried to help me on this matter" "Thanks for the info."
Story	"Well, as I was informed from the Microsoft support center, it's a "known bug"…" "The area I know is trading systems, but this is a not an atypical challenge for library vendors in many vertical markets." "Well, I'm implementing something like that for an automatically parallelizing compiler (which means that I don't have to worry about deadlocks, just about adhering to data dependencies)."
Personal Aside	"Thank you _____ for the prompt reply." "A trick that I think I heard _____ call "a dynamic object"."